COMPARISON OF ELECTRODYNAMIC FRAGMENTATION AND CRUSHING OF CONVERTER SLAG AND EOL BRICKS

Simon MICHAUX, Ryan McCASKER, Hassan BOUZAHZAH, Eric PIRARD,
Evgeni VISARIEV GeMMe – Université de Liège

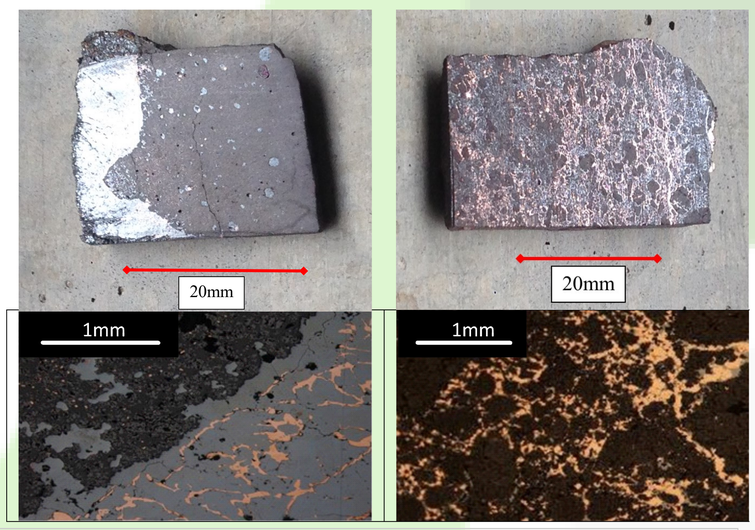
Context

Electrodynamic fragmentation (EDF) was compared to conventional crushing in terms of liberation efficiency with two pyrometallurgical waste products, converter slag and end of life furnace bricks (EOL). EDF fractures material through the application of high voltage electrical discharge with high frequency pulses resulting in the formation of plasma along grain boundaries thus producing selective breakage

Experimental Design

Experimental purpose

This paper is the preliminary results of an ongoing study of EDF of pyrometallurgical waste products. Samples supplied by Aurubis from the Pirdop copper smelting plant in Bulgaria.

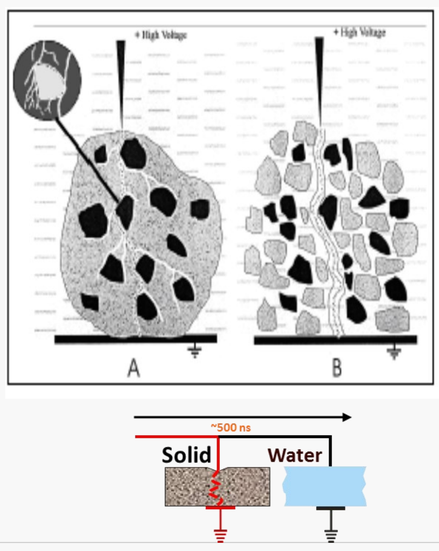


Copper slag (left) and End of Life (EOL) furnace bricks (right)

An intact sample of copper slag was crushed in a jaw crusher and then collected. Another intact sample of the same material was put into the electrodynamic fragmentation instrument (Selfrag) and broken according to design parameters

How does HV fragmentation work?

- Based on a HV physical specificity
- At short pulse rise time target solids are more conductive than water (thus path of least resistance)
- Creating a electrostatic charged stress field with geometry defined by material texture
- Discharge occurs through solid, causing strong internal shockwaves across stress field geometry
- Resulting in selective breakage



Fragmentation process through material with multiple subcomponents

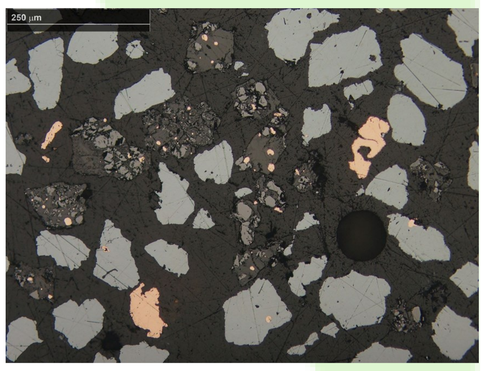
Electrodynamic breakage targets

- Seek to liberate a sub-component that has very different material properties and shape parameters to its host matrix
- We wish to liberate this sub-component intact and as undamaged as possible
- The sub-component is usually the valuable target element
- The matrix is not valuable in its broken form but could be valorised of metals are removed
- The amount of fines generated is often required to be reduced as much as possible

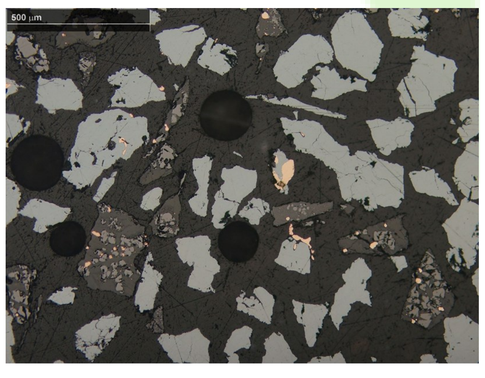
The SELFRAG unit installed and commissioned at the Univerity of Liege

Preliminary results and future possibilities

Copper furnace slag



Selfrag broken, 250 pulses, 180kV
-300+150µm fraction



Crushed in jaw crusher
-300+150µm fraction

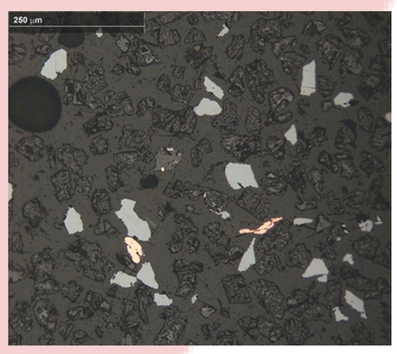
Crushed Copper Slag - discussion

- In comparison, the crushed samples primarily had binary and tertiary phase particles
- In the crushed sample, most of the copper measured was associated with digenite
- The copper particles seen in the crushed sample were smaller in size compared to the EDF broken samples
- Fine fraction (5-10mm) Copper droplets locked in Silicate-magnetite slag for both crushed and EDF samples

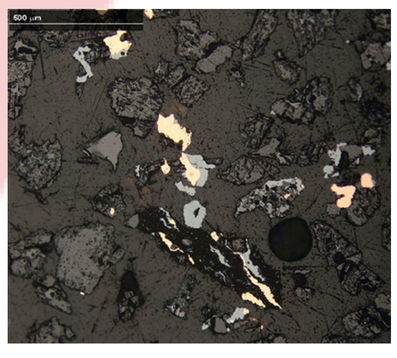
EOL furnace bricks- discussion

- There was a clear distinction between the breakage methods
- The EDF had liberated the respective minerals at comparatively coarse grain sizes with a distinct preference to intact grains
- The EOL bricks subject to EDF were well liberated into mono phase particles at a comparatively coarse grain size when compared to the crushed samples
- There was fewer observations of the fine droplets of copper locked in other minerals
- Most of the pure copper observed was either completely liberated or partially liberated in both EDF and crushed samples

EOL Furnace Bricks



Selfrag broken, 150 pulses, 180kV
-300+150µm fraction



Crushed in jaw crusher
-300+150µm fraction

Université de Liège
GeMMe
Génie Minéral, Matériaux & Environnement